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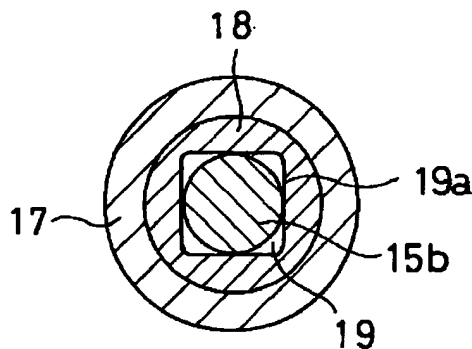
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(54) 【発明の名称】 電動歯ブラシ等に使用される軸受構造

(57) 【要約】

【目的】 本発明の目的は、モータを駆動する電源の消費電力を少なくできるようにした電動歯ブラシ等に使用される軸受構造を得ることにある。

【構成】 モータ6の動力により往復動される駆動軸15を支持するすべり軸受18の軸受孔19、またはこの軸受孔19に嵌合される前記駆動軸15の中間部分15bの少なくとも一方の軸直角方向の断面形状を、非円形にするとともに、前記すべり軸受18の前記軸受孔19を作る軸受面19aと前記駆動軸15の孔嵌合部分15bとを周方向の数箇所接触させた。



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【特許請求の範囲】

【請求項1】 軸方向または周方向に往復動される可動軸をすべり軸受で支持してなり電動歯ブラシ等に使用される軸受構造において、前記すべり軸受の軸受孔またはこの軸受孔に嵌合される前記可動軸の孔嵌合部分の少なくとも一方の軸直角方向の断面形状を非円形にするとともに、前記すべり軸受の前記軸受孔を作る軸受面と前記可動軸の孔嵌合部分とを周方向の数箇所で接触させたことを特徴とする電動歯ブラシ等に使用される軸受構造。

【発明の詳細な説明】

【0001】

【産業上の利用分野】 本発明は、歯部を磨くための電動歯ブラシ等に使用され、その消費電力を少なくできるようにした軸受構造に関する。

【0002】

【従来の技術】 電動歯ブラシは、筒状の本体ケースに動力源としてのモータおよびこの動力を受けて動作する駆動機構を内蔵するとともに、本体ケースの上端から突出された駆動軸に歯ブラシを着脱可能に取付けて、前記駆動機構により駆動軸とともに歯ブラシを高速度で軸方向に往復直線運動または周方向に往復回転運動させて、歯磨きに使用するものである。

【0003】 以上のようにモータの動力で往復動される駆動軸（可動軸）は、その1〜2か所をすべり軸受で支持されている。そして、従来において、すべり軸受の軸受孔の軸直角方向の断面は円形であるとともに、この軸受孔に嵌合する駆動軸の軸直角方向の断面も円形をなしており、駆動軸はその外周面をすべり軸受の軸受孔をなす軸受面に摺接させながら往復動されるものであった。

【0004】

【発明が解決しようとする課題】 前記のような従来の軸受構造では、駆動軸と軸受の軸受面との接触面積が大きいから、駆動軸の摺動抵抗が大きく、それに伴い消費電力が大きいう問題があった。そのため、モータの電源が乾電池である場合には、その電池寿命が短い。ちなみに、単3形アルカリ電池を電源とした従来の電動歯ブラシ（ただし、駆動軸はステンレス製、すべり軸受がポリアセタール樹脂であって、駆動軸が直線往復動するもの）に、歯ブラシを装着しこれに300gの負荷を掛けた状態で連続運転した時の、運転時間に対する電池電圧の変化を測定した結果は、図5中Aに示され、軸受構造での負荷が大きいために使用開始時点での電池電圧が1.2Vと小さく、実使用可能電圧（その電池電圧は0.9Vであって、それ以下では駆動軸に対し適正な駆動力を与えられない電圧）に、約25分の短い時間で達することが分かった。本発明の目的は、動力源を駆動する電源の消費電力を少なくできるようにした電動歯ブラシ等に使用される軸受構造を得ることにある。

【0005】

【課題を解決するための手段】 前記目的を達成するため

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に、本発明の電動歯ブラシ等に使用される軸受構造は、動力源の動力により軸方向または周方向に往復動される可動軸を支持するすべり軸受の軸受孔、またはこの軸受孔に嵌合される前記可動軸の孔嵌合部分の少なくとも一方の軸直角方向の断面形状を、非円形にするとともに、前記すべり軸受の前記軸受孔を作る軸受面と前記可動軸の孔嵌合部分とを周方向の数箇所で接触させたものである。

【0006】

10 【作用】 上記の構成によれば、すべり軸受の軸受孔または可動軸の孔嵌合部分の少なくとも一方の断面形状を非円形としたから、すべり軸受の軸受面と前記孔嵌合部分とは周方向の数箇所で接触する。そのため、軸受孔に対する可動軸の嵌合精度が損なわれることがないとともに、軸受孔と可動軸との接触面積が小さくなって可動軸の摺動抵抗を少なくできる。

【0007】

【実施例】 以下、図1〜図5を参照して本発明の第1実施例を説明する。

20 【0008】 図2中符号1は手でしっかりと握れる太さと長さを有した筒状をなす樹脂製の本体ケースで、その下端開口は着脱可能に螺合された蓋2で閉じられている。この本体ケース1には駆動機構3が内蔵されているとともに、この機構3の電源となる電池4が収納されている。電池4には乾電池または蓄電池が用いられ、この実施例は前記蓋2の開閉を伴って出し入れされる乾電池を用いた場合である。また、図2中符号5は電池押しばねを示している。

30 【0009】 駆動機構3は図2および図3に示すように構成されている。つまり、符号6は電池5の電力が印加されることにより動作される動力源としてのモータで、その出力軸には駆動歯車7が取付けられている。この歯車7には中間歯車8が噛み合わされ、この歯車8には中間平歯車9が固定されている。中間平歯車9には従動平歯車10が噛み合わされている。図2〜図4中符号11、12は夫々歯車軸で、歯車軸11は前記歯車8、9を支持し、歯車軸12は前記歯車10を支持している。これらの歯車軸11、12は本体ケース1の内面に固定された歯車ベース13に支持されている。さらに、従動平歯車10にはその中心から偏心した位置に駆動ピン14が突設されている。

40 【0010】 この駆動機構3には可動軸としての駆動軸15が駆動ピン14に連動するように取付けられている。つまり、例えばステンレス製の駆動軸15にはその軸直角方向に沿って横長な係合溝16が設けられ、この溝16に駆動ピン14が挿入して係合されている。駆動軸15は本体ケース1の上端部に形成された筒状の軸受支持部17を貫通して本体ケース1の上端から突出されている。この駆動軸15の本体ケース1の外に突出された先端部には軸直角方向の断面が四角な角軸部15aが

形成されている。前記係合溝6を設けた下端部および上端の角軸部15aを除いた駆動軸15の中間部分15bは、図1に示すように断面円形の丸棒で形成されている。

【0011】前記軸受支持部17にはすべり軸受18が内蔵されており、この軸受18に駆動軸15が貫通されている。すべり軸受18はポリアセタール樹脂の一体成形品であって、図1に示すように中央部に上下両端が夫々開放された軸受孔19を有している。この軸受孔19はその軸直角方向に沿う断面を非円形例えば略四角形状にして形成されている。そして、この軸受孔19には駆動軸15の断面円形をなす中間部分(つまり孔嵌合部分)15bが嵌合されている。そのため、軸受孔19を作るすべり軸受18の軸受面19aに、前記中間部分15bの周面の4か所を接触させて、駆動軸15がすべり軸受18に摺動自在に支持されている。

【0012】図2に示すように駆動軸15の角軸部15aには、歯ブラシ20が着脱可能に取付けられている。歯ブラシ20は柄21の先端部にブラシ毛22を植毛するとともに、柄21の基端部21aに角軸部15aの先端部に着脱可能に嵌合される孔などからなる嵌合部21bを設けて形成されている。嵌合部21bと角軸部15baとの嵌合により歯ブラシ20は、駆動軸15に対して位置決めされて、駆動軸15の周方向に不用意に回ることがないように取付けられるものである。

【0013】なお、図4に示すように歯ブラシ20の往復の変位量Lは3~7mmに定められ、そのために、前記駆動ピン14の従動平歯車10の中心に対する偏心量1を1.5~3.5にしてある。また、図2に示すように本体ケース1の上端部外面には、柔軟性に富むゴムで形成された防水キャップ23が、駆動軸15の本体ケース1外に突出した部分をその周囲から覆って取付けられている。

【0014】前記構成の電動歯ブラシのモータ6に通電して駆動機構3を動作させると、駆動歯車7の回転が、中間歯車8との噛み合いでこれと中間平歯車9に伝えられた後、この歯車9との噛み合いで従動平歯車10に伝えられて、この歯車10を回転させる。このため、駆動ピン14が同時に前記偏心量1を半径とする偏心円運動を行いながら駆動軸15の係合溝16内を移動するから、これら駆動ピン14と係合溝16との係合を介して、駆動軸15が軸方向に前記偏心量1の2倍の量を変位とする直線往復動を行う。なお、この駆動軸15の往復動作は高速であって、毎分2000~3000回(1往復を1回とする)行われる。

【0015】したがって、歯ブラシ20全体がその軸方向に3~7mmのストロークで往復動される。このようにして高速で直線往復動される歯ブラシ20のブラシ毛22を歯等に軽く押し当てることにより、歯部をブラッシングできる。このブラッシングにおいて、防水キャ

プ23はその柔軟性により可撓変形するので、容易に駆動軸15の動きに追従でき、駆動軸15の動作を妨げることがない。

【0016】そして、以上のように高速で往復動される駆動軸15はすべり軸受18で支持されているが、この軸受18の軸受孔19は四角形状であるので、この孔19を貫通する駆動軸15の断面円形の中間部分15bは、図1に示すように軸受面19aに対して4か所で線接触している。

【0017】そのため、すべり軸受18と駆動軸15との接触面積が小さく、この駆動軸15の摺動抵抗を少なくできる。したがって、前記モータ6を駆動する電池4の消費電力を少なくできるとともに、この電池4の寿命を延ばすことができる。

【0018】ちなみに、前記構成の電動歯ブラシに、電池4に単3形アルカリ電池を使用するとともに歯ブラシ20を装着しこれに300gの負荷を掛けた状態で連続運転した時の、運転時間に対する電池電圧の変化を測定した結果が、図5中Bに示されている。この比較試験によれば、軸受構造での負荷が小さいために使用開始時点での電池電圧が1.4V強と大きく、実使用可能電圧(0.9V)に達するまでに約63分の時間を費やし、従来の軸受構造を備えた電動歯ブラシに比較して、2.52倍の寿命向上を確認できた。このような寿命向上により、電池4の交換頻度(なお、電池4が蓄電池の場合には充電頻度)を少なくできる。

【0019】また、図5中Bから明らかなように電池電圧の低下が少ないから、モータ6に与える電力も多く、よってモータ6のトルク、換言すれば歯ブラシ20の駆動力も長時間にわたって大きく維持できる。その上、既述のように駆動軸15の周方向の4か所が軸受面19aに接触しているので、軸受孔19に対する駆動軸15の嵌合精度が損なわれることがなく、したがって、駆動軸15のすべり軸受18に対するがたつきが大きくなって、騒音を高めるようなことがない。図6~図9は夫々異なる他の実施例の要部を示した前記図1相当の断面図であり、以下、前記第1実施例とは異なる部分についてのみ説明する。

【0020】図6に示した第2実施例は、軸受孔19の軸直角方向の断面を四角ではなく、長さが等しい三つの平面の端部同志を円弧面で繋いでなる軸受面19aで軸受孔19を形成した構成である。このような軸受孔19を有した軸受構造によれば、駆動軸15の断面円形をなす中間部分15bの外周3か所が軸受面19aに線接触するから、接触面積および駆動軸15の摺動抵抗が夫々更に小さくなって、駆動軸15を駆動するモータの消費電力をより少なくできる。

【0021】図7に示した第3実施例は、すべり軸受18の軸方向に延びるビード19bを三つ以上軸受け面19aに突設して、これらビード19bの丸まった先端ま

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たは凹面（図示しない）を駆動軸15の断面円形をなす中間部分15bに接触させて、駆動軸15を支持した構成である。このような軸受構造においても、駆動軸15の周方向数箇所がすべり軸受18に線接触（または面接触）するから、駆動軸15の撓動抵抗を小さくして、本発明の所期の目的を達成できる。

【0022】図8に示した第4実施例は、すべり軸受18の軸受孔19を断面円形とするとともに、この軸受孔19に嵌合する駆動軸15の中間部分15bの軸直角方向の断面を四角形状とし、かつ、前記中間部分15bの四隅を夫々円弧面に形成して、これら円弧面を、軸受孔19を作る軸受面19aに線接触ないしは面接触（これらの接触の仕方は前記四隅の円弧の曲率によって決まる。）させた構成である。そして、このような軸受構造においても、駆動軸15の周方向の4か所が軸受面19aに接触するから、接触面積および駆動軸15の撓動抵抗が夫々小さくなって、駆動軸15を駆動するモータの消費電力をより少なくできる。

【0023】図9に示した第5実施例は、すべり軸受18の断面を四角状軸受孔19に嵌合される駆動軸15の中間部分15bの軸直角方向の断面を四角形状とし、かつ、その四隅を夫々円弧面に形成して、これら円弧面を、前記軸受孔19を作る軸受面19aに線接触させた構成である。そして、このような軸受構造においても、駆動軸15の周方向の4か所が軸受面19aに線接触するから、接触面積および駆動軸15の撓動抵抗が夫々小さくなって、駆動軸15を駆動するモータの消費電力をより少なくできる。

【0024】なお、本発明は前記各実施例に制約されず、本発明は電源にコードを介して商用交流電源を利用するタイプの電動歯ブラシにも実施できることはいうまでもなく、駆動機構の動力源として電磁的に振動を発生する電磁バイブレータを用いてもよいとともに、駆動軸（可動軸）の往復動は軸方向ではなく周方向に往復動させるものでも良い。また、本発明は往復動されるブラン

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ジャを有し、このブランジャの先端に取付けた叩打子を、使用者の患部に打ち当てるブランジャタイプの電動マッサージ等にも適用できる。さらに、すべり軸受18は本体ケース1と一体に成形しても良い。

【0025】

【発明の効果】以上詳記したように本発明の電動歯ブラシ等に使用される軸受構造においては、軸受孔に対する可動軸の嵌合精度が損なわれることがないとともに、軸受孔に対する可動軸の撓動抵抗を小さくして、動力源を駆動する電源の消費電力を少なくできるという効果がある。

【図面の簡単な説明】

【図1】本発明の第1実施例に係り図2中Z-Z線に沿って軸受構造を示す断面図。

【図2】同第1実施例に係り電動歯ブラシの全体を示す縦断側面図。

【図3】同第1実施例に係り電動歯ブラシの駆動機構を示す斜視図。

【図4】同第1実施例に係り駆動機構による歯ブラシの往復動の原理を示す図。

【図5】電動歯ブラシの運転時間と電池電圧との関係を示す図。

【図6】本発明の第2実施例に係る軸受構造を示す断面図。

【図7】本発明の第3実施例に係る軸受構造を示す断面図。

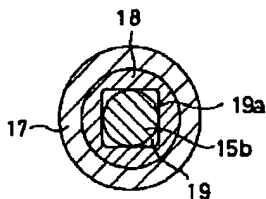
【図8】本発明の第4実施例に係る軸受構造を示す断面図。

【図9】本発明の第5実施例に係る軸受構造を示す断面図。

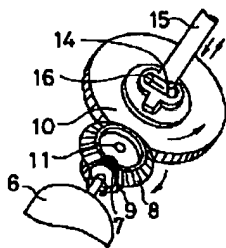
【符号の説明】

6…モータ（動力源）、16…駆動軸（可動軸）、16b…駆動軸の中間部分（孔嵌合部分）、18…すべり軸受、19…軸受孔、19a…軸受面。

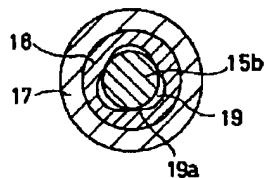
【図1】



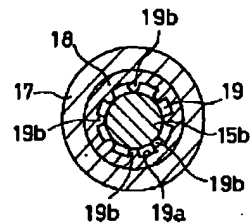
【図3】



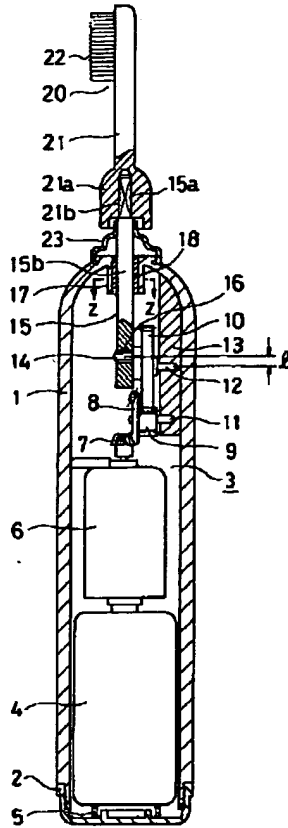
【図6】



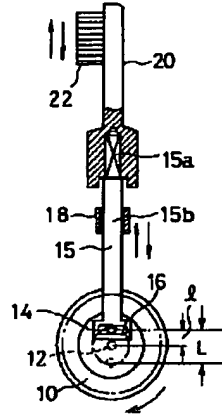
【図7】



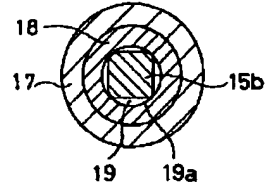
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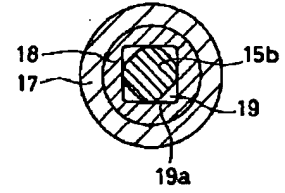
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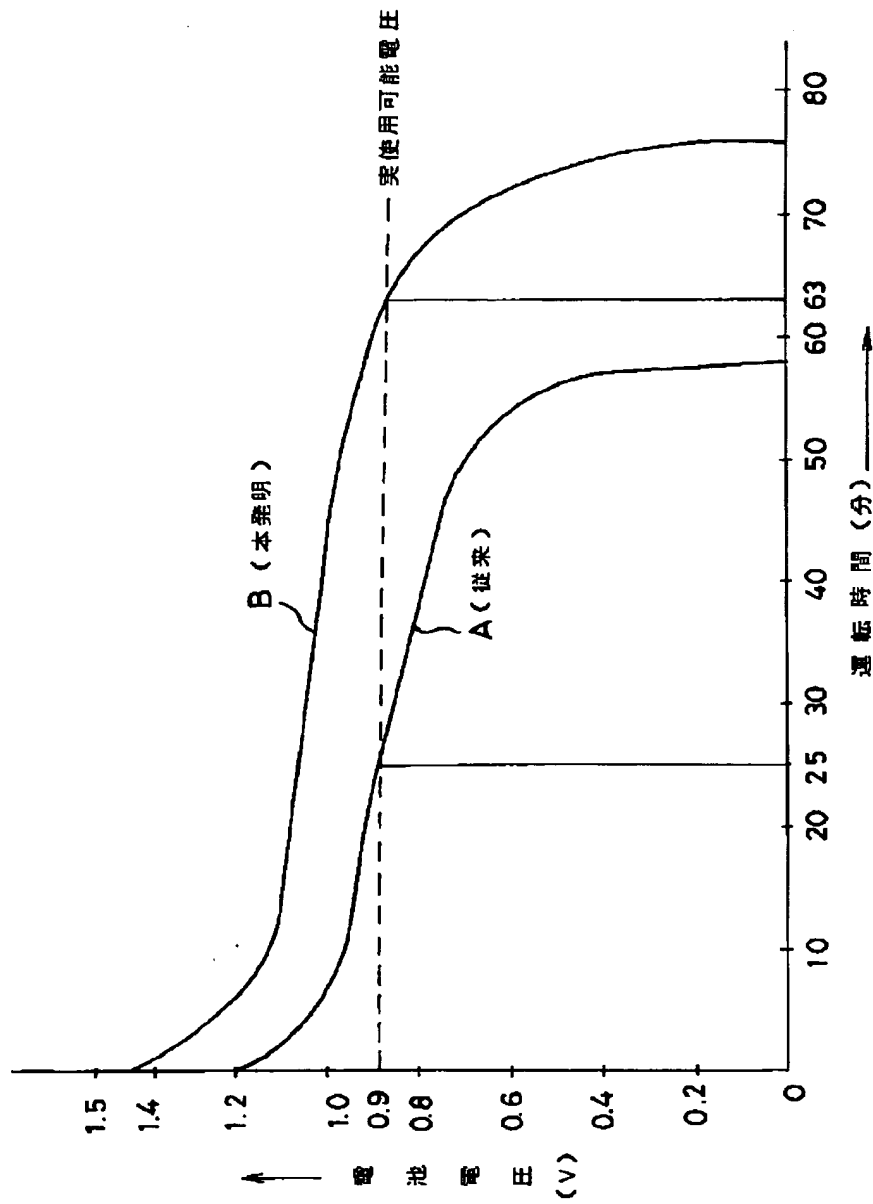
【図8】



【図9】



【図5】



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BEARING STRUCTURE USED IN AN ELECTRIC TOOTHBRUSH AND THE LIKE

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Abstract

Purpose

The purpose of this invention is to obtain a bearing structure for use in an electric toothbrush and the like, wherein the electricity consumption from a power source that drives the motor is reduced.

Structure

The cross section in the direction orthogonal to the shaft of a bearing hole (19) of a slide bearing (18) that supports a driving shaft (15) reciprocated by the power of a motor (6), and/or the intermediate section (15b) of the aforementioned driving shaft (15) that fits into this bearing hole (19), is formed in a non-circular shape, and the bearing surface (19a) formed by the aforementioned bearing hole (19) of the aforementioned slide bearing (18), makes contact at several locations in the circumferential direction with a part (15b) of the aforementioned driving shaft (15) that fits in the hole.

Claim

1. A bearing structure, used in an electric toothbrush and the like, wherein a movable shaft, which reciprocates in the direction of the shaft or in the circumferential direction, is supported by a slide bearing, characterized in that the cross section in the direction orthogonal to the shaft of a bearing hole of the aforementioned slide bearing, and/or the part of the aforementioned movable shaft that fits into this bearing hole, are/is formed into a non-circular shape, and the bearing surface formed by the aforementioned bearing hole of the aforementioned slide bearing makes contact with the part of the aforementioned movable shaft that fits in the hole at several locations in the circumferential direction.

Detailed explanation of the invention

[0001]

Industrial application field

This invention concerns a bearing structure that is used, for example, in an electric toothbrush for brushing teeth, and by which the consumption of electricity is reduced.

[0002]

Prior art

An electric toothbrush houses a motor as a power source, and a driving mechanism, which receives this power, within a cylindrically shaped main case. These operate a toothbrush, attached in a freely attachable and detachable manner to the driving shaft, that projects from the top end of the main case. This is used for brushing teeth by means of a reciprocating linear motion in the direction of the shaft or a reciprocating circular motion in the circumferential direction of the toothbrush, at high speed, together with the driving shaft of the aforementioned driving mechanism.

[0003]

The driving shaft (movable shaft) that is reciprocated by the power of the motor, as described above, is supported by a slide bearing at 1-2 locations. Conventionally, the cross-section of the bearing hole of the slide bearing in the direction orthogonal to the shaft was circular, and the cross-section of the driving shaft that fits into this bearing hole, in the direction orthogonal to the shaft, was also circular, and the driving shaft reciprocated while slidingly contacting the bearing surface of the bearing hole of the slide bearing with its outer circumferential surface.

[0004]

Problem to be solved by the invention

In the aforementioned conventional bearing structure, the contact area between the driving shaft and the bearing surface for the driving shaft was large, making the sliding resistance to the driving shaft large, and the concomitant high power consumption became an issue. As a result, the battery life is short when using dry cell batteries as the power source of the motor. As a reference, Figure 5A shows the results of measuring the change in battery voltage over time for a conventional electric toothbrush that uses AAA alkaline batteries as a power source (where the driving shaft is stainless steel, the slide bearing is made from polyacetal resin, and the driving shaft has a linear reciprocating motion) and continuously operating this with toothbrush attached and with a 300 g load applied. It is acknowledged that the battery voltage is low at 1.2 V, at the beginning of use because the bearing structure load is high, and the actual usable voltage (a battery voltage of 0.9V, below which sufficient driving force cannot be supplied to the driving shaft) is reached quickly, in about 25 min. The purpose of this invention is to obtain a bearing structure for use in an electric toothbrush, for example, in which the electrical power consumption from the power source is reduced.

[0005]

Means to solve the problem

In achieving the aforementioned purpose, the bearing structure of this invention, used in an electric toothbrush, for example, is characterized in that the cross section, in the direction orthogonal to the shaft, of a bearing hole of a slide bearing that supports a driving shaft reciprocated by a power source in the direction of the shaft or in the direction of the circumference, or the part of the aforementioned movable shaft that fits in the hole that fits into this bearing hole, is formed in a non-circular shape, and the bearing surface, formed by the aforementioned bearing hole of the aforementioned slide bearing, makes contact with a part of

the aforementioned movable shaft that fits in the hole at several locations in the circumferential direction.

[0006]

Function

In the aforementioned structure, the cross section of at least either the bearing hole of the slide bearing or the part of the movable shaft that fits in the hole is formed in a non-circular shape, so that the bearing surface of the slide bearing and the aforementioned part that fits in the hole make contact at several locations in the circumferential direction. As a result, the accuracy of the fit between the movable shaft and the bearing hole is not lost, and the contact area between the bearing hole and the movable shaft is made small, so that the sliding resistance of the movable shaft can be reduced.

[0007]

Application examples

Application Example 1 of this invention will be explained by referring to Figures 1-5 below.

[0008]

In Figure 2, (1) is a main case made of a resin forming a cylindrical shape having a thickness and length that can be firmly held by one's hand, and an opening at the lower end is closed by a lid (2) that is screwed on in an attachable and detachable manner. A driving mechanism (3) is housed in this main case (1), and a battery (4), that is used as a power source for this mechanism (3) is also housed. Dry cell batteries or rechargeable batteries are used as the battery (4). A dry cell battery that is inserted and removed by opening and closing the aforementioned lid (2) is used in this application example. In Figure 2, (5) indicates a spring that pushes against the battery.

[0009]

The driving mechanism (3) has the structure indicated in Figures 2 and 3. More precisely, (6) is a motor as a driving means that is operated when electrical power from the battery (5) is applied, and a driving gear (7) is attached to its output shaft. An intermediate [bevel] gear (8) engages with this gear (7), and an intermediate spur gear (9) is attached to this gear (8). A coupled spur gear (10) engages with the intermediate spur gear (9). (11) and (12) in Figures 2-4 are respective gear shafts, the gear shaft (11) supporting the aforementioned gears (8) and (9), and the gear shaft (12) supporting the aforementioned gear (10). These gear shafts (11) and (12)

are supported by a gear base (13) that is fixed to the inner surface of the main case (1). Furthermore, a driving pin (14) projects from the coupled spur gear (10) at an eccentric position relative to the center.

[0010]

A driving shaft (15) is attached as a movable shaft to this driving mechanism (3) by engaging with the driving pin (14). More precisely, a long horizontal engagement groove (16) is provided to a stainless steel driving shaft (15) in the direction orthogonal to the shaft, for example, and driving pin (14) is inserted into and engages with this groove (16). The driving shaft (15) projects out from the upper end of the main case (1) through a cylindrical bearing supporting part (17) that is formed at the upper end of the main case (1). A square shaft part (15a) with a square cross-section in the direction orthogonal to the shaft is formed at the tip area of this driving shaft (15) projecting outside of the main case (1). The middle section (15b) of the driving shaft (15), except for the lower end where the aforementioned engagement groove (6) is provided and the square shaft part (15a) at the upper tip, is formed of a round bar with a circular cross section, as shown in Figure 1.

[0011]

A slide bearing (18) is housed within the aforementioned bearing supporting part (17), and the driving shaft (15) passes through this bearing (18). The slide bearing (18) is an integrally molded product made of a polyacetal resin, and it has a bearing hole (19) in the center that is open at its upper and lower ends, as shown in Figure 1. This bearing hole (19) is formed, in the direction orthogonal to the shaft, with a non-circular cross section such as a near-quadrilateral shape, for example. The middle section (15b) with a circular cross section of the driving shaft (15) (in other words, the part that fits in the hole) is fitted into this bearing hole (19). As a result, the circumferential surface of the aforementioned middle section (15b) comes into contact with the bearing surface (19a) of the slide bearing (18), in which is formed the bearing hole (19), at 4 locations, and the driving shaft (15) is supported by the slide bearing (18) in a freely slideable manner.

[0012]

As shown in Figure 2, a toothbrush (20) is attached to the square shaft part (15a) of the driving shaft (15) in a freely attachable and detachable manner. Toothbrush bristles (22) are implanted at the tip of a handle (21) of the toothbrush (20), and a fitting part (21b), consisting of a hole, for example, in the base (21a) of the handle (21), is formed to fit onto the top end of the square shaft part (15a) in an attachable and detachable manner. The toothbrush (20) is positioned

to the driving shaft (15) when the fitting part (21b) fits onto the square shaft part (15ba) [sic; (15a)], and it is attached so that it does not rotate unnecessarily in the circumferential direction of the driving shaft (15).

[0013]

As shown in Figure 4, the amount of displacement L during reciprocation of the toothbrush (20) is designed to be 3-7 mm, and the amount of eccentricity l of the aforementioned driving pin (14) relative to the center of the coupled spur gear (10) is accordingly set to 1.5-3.5. As shown in Figure 2, a water-proof cap (23) formed of a highly-flexible rubber is attached to the outer surface of the upper end of the main case (1) to cover from the periphery the area where the driving shaft (15), projects outside the main case (1).

[0014]

When the driving mechanism (3) is operated by sending electricity to the motor (6) of an electric toothbrush with the above-described structure, rotation of the driving gear (7), is transmitted to the coupled middle gear (8) and to the middle spur gear (9), and is then transmitted to the coupled spur gear (10) by engagement with gear (9), causing gear (10) to rotate. As a result, the driving pin (14) at the same time follows a circular path with the aforementioned eccentric amount l as the radius, and moves inside the engagement groove (16) of the driving shaft (15). The driving shaft (15) therefore has a linear reciprocating motion, wherein it is displaced 1-2 times the amount of the aforementioned eccentric amount l in the direction of the shaft by virtue of the engagement between driving pin (14) and engagement groove (16). This driving shaft (15) reciprocates at the high speed of 2000-3000 times per min(1 reciprocation being counted as 1 time).

[0015]

Accordingly, the entire toothbrush (20) reciprocates with a stroke of 3-7 mm in the direction of the shaft. By lightly pressing the toothbrush bristles (22) of the toothbrush (20) with this high-speed linear reciprocating motion against the teeth, for example, the teeth can be brushed. During this brushing, the waterproof cap (23) flexibly changes its shape by virtue of its flexibility, and it can easily follow the movement of the driving shaft (15) without impeding the movement of the driving shaft (15).

[0016]

During this, the driving shaft (15), which has the high-speed reciprocating motion described above, is supported by the slide bearing (18). The shape of the bearing hole (19) of this

bearing (18) is a square, so that the middle part (15b) with a circular cross-section of the driving shaft (15) passes through this hole (19) and makes a linear contact with the bearing surface (19a) at 4 locations, as is shown in Figure 1.

[0017]

As a result, the contact area between the slide bearing (18) and the driving shaft (15) is small, and the sliding resistance with this driving shaft (15) can be made small. Accordingly, the consumption of electricity from the battery (4) that drives the aforementioned motor (6) can be made small, and the life of this battery (4) can be extended.

[0018]

For reference, Figure 5B shows the results of measuring the change in battery voltage over time for an electric toothbrush with the aforementioned structure in continuous operation, using a AAA alkaline battery as the battery (4) and with toothbrush (20) attached and a 300 g load applied. In this comparison test, the battery voltage at the starting point of use is high, at 1.4V, because the load from the bearing structure is small, and about 63 min elapse before the actual usable voltage (0.9 V) is reached. When compared to an electric toothbrush equipped with a conventional bearing structure, an improvement in working life of 2.52 times is confirmed. Such an improvement in the working life means that the frequency of replacing battery (4) (of the frequency of recharging battery (4) when using a rechargeable battery) can be reduced.

[0019]

As is clearly shown in Figure 5B, the battery voltage decrease is small, so that the power delivered to the motor (6) is large. Accordingly, a high torque can be maintained from motor (6), or in other words, a high driving power of the toothbrush (20) can be maintained for a long time. Moreover, the driving shaft (15) comes into contact with the bearing surface (19a) at 4 locations in the circumferential direction, as described above, so that the accuracy of the fit of the driving shaft (15) with the bearing hole (19) is not lost. Accordingly, the noise does not increase when the offset of the driving shaft (15) from the bearing surface (18) increases. Figures 6-9, respectively, show cross-sectional diagrams equivalent to the aforementioned Figure 1 showing the chief part of different application examples. Only parts that are different from the aforementioned Application Example 1 will be explained.

[0020]

Application Example 2 indicated in Figure 6 has a structure wherein the cross-section of the bearing hole (19) in the direction orthogonal to the shaft is not a square, but the bearing hole

(19) is formed with a bearing surface (19a), wherein the ends of 3 flat surfaces of equal length are connected by circular surfaces. By means of a bearing structure with such a bearing hole (19), 3 parts of the outer circumference of the middle section (15b), which has a circular cross section, of the bearing shaft (15) have a linear contact with the bearing surface (19a). Therefore, the contact area and the sliding resistance of the driving shaft (15) are respectively further reduced, and the electricity consumption of the motor that drives the driving shaft (15) can be further reduced.

[0021]

Application Example 3, shown in Figure 7, has a structure in which 3 or more beads (19b), extending in the direction of the shaft, of slide bearing (18) project from the bearing surface (19a), and the rounded end or the recessed surface (not shown in the diagram) of these beads (19b) makes contact with the middle section (15b) having a circular cross-section of the driving shaft (15), and supports the driving shaft (15). In such a bearing mechanism, the driving shaft (15) still has a linear contact (or a surface contact) with the slide bearing (18) at several locations in the circumferential direction, and the sliding resistance of the driving shaft (15) can be made small, and the intended purpose of this invention can be attained.

[0022]

Application Example 4, shown in Figure 8, has a structure in which the bearing hole (19) of the slide bearing (18) is formed with a circular cross-section, the cross-section in the direction orthogonal to the shaft of the middle section (15b) of the driving shaft (15), which fits into this bearing hole (19), is formed in the shape of a square, the 4 corners of the aforementioned middle section (15b) are respectively formed as circular surfaces, and these circular surfaces make linear or surface contact (depending on the curvature at the aforementioned 4 corners) with the bearing surface (19a) formed by the bearing hole (19). In this bearing structure as well, 4 parts of the driving shaft (15) in the circumferential direction make contact with the bearing surface (19a), the contact area and the sliding resistance of the driving shaft (15) are respectively made small, and the electricity consumption of the motor that drives the driving shaft (15) can be further reduced.

[0023]

Application Example 5, shown in Figure 9, shows a structure in which the cross-section of the slide bearing (18), and the cross-section of the middle section (15b) of the driving shaft (15) that fits into the quadrilateral bearing hole (19), are respectively formed in quadrilateral shapes in the direction orthogonal to the shaft, 4 corners are also respectively formed as circular

surfaces, and these circular surfaces make linear contact with the bearing surface (19a) formed by the aforementioned bearing hole (19). In such a bearing structure, the driving shaft (15) also has a linear contact with the bearing surface (19a) at 4 locations in the circumferential direction, so that the contact area and the sliding resistance of the driving shaft (15) are respectively reduced, and the electricity consumption of the motor that drives the driving shaft (15) is further reduced.

[0024]

This invention should not, however, be limited by each of the aforementioned application examples, and this invention can certainly be applied to types of electric toothbrushes that connect with a cord to a commercial ac power source. The driving mechanism can also be powered by an electromagnetic vibrator, and the reciprocating motion of the driving shaft (movable shaft) can be a reciprocating motion in the circumferential direction instead of the direction of the shaft. This invention can also be applied to a plunger type of electric massager, for example, that is equipped with a plunger that reciprocates and a hitting part, attached to the tip of this plunger, that hits the user's affected area, for example. Furthermore, the slide bearing (18) can be integrally molded together with the main case (1).

[0025]

Effect of the invention

As explained in detail above, in the bearing structure used in an electric toothbrush in this invention, for example, the accuracy of the fit of the movable shaft with the bearing hole is not lost, the sliding resistance of the movable shaft in the bearing hole can be made small, and the electricity consumption from the power source that drives the device can be reduced.

Brief description of the figures

Figure 1 is a cross-sectional diagram showing the bearing structure, along line Z-Z in Figure 2, in Application Example 1 of this invention.

Figure 2 is a side view vertical section showing the entire electric toothbrush in Application Example 1 of this invention.

Figure 3 is an oblique view showing the driving mechanism of the electric toothbrush in Application Example 1 of this invention.

Figure 4 is a diagram showing the principle of the reciprocating motion of a toothbrush caused by the driving mechanism in Application Example 1 of this invention.

Figure 5 is a diagram showing the relationship between the length of operation of the electric toothbrush and the battery voltage.

Figure 6 is a cross section showing the bearing mechanism in Application Example 2 of this invention.

Figure 7 is a cross section showing the bearing mechanism in Application Example 3 of this invention.

Figure 8 is a cross section showing the bearing mechanism in Application Example 4 of this invention.

Figure 9 is a cross section showing the bearing mechanism in Application Example 5 of this invention.

Explanation of the numbers

6 ...Motor (power source); 16 ...Driving shaft (movable shaft); 16b ...Middle section of the driving shaft (part that fits in the hole); 18 ...Slide bearing; 19 ...Bearing hole; and 19a ...Bearing surface.

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Key:	1	Battery voltage (V)
	2	Operational time (min)
	3	B (This invention)
	4	A (Conventional)
	5	Actual usable voltage

Figure 6

Figure 7

Figure 8

Figure 9